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REPORT AND PRELIMINARY RESULTS OF
POSEIDON CRUISE 248,
LAS PALMAS - LAS PALMAS, 15.2. - 26.2.1999

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1) Participants

Participants Poseidon cruise P 248

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Hayn, Christina	GeoB	Incubations, chlorophyll
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Godoy, Juana	ICCM	oxygen, nutrients, chlorophyll, incubations
Cianca, Andres	ICCM	oxygen, nutrients, chlorophyll XBT
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ICCM : Instituto Canario de Ciencias Marinas, Apto. Correos 55, 35200 Telde de Gran Canaria, Spain

CSIC: Unidad de Gestión de Buques Oceanográficos, Instituto de Ciencias del Mar. CSIC, Paseo Juan de Borbon s/n, 08039 Barcelona Barcelona, Spain

2) Research Programme

During Poseidon cruise 248, work was carried out for the Spanish-German time-series programme ESTOC (European Station for Time-series in the Ocean, Canary Islands) and the EU programme CANIGO (Canary Islands Azores Gibraltar Observations).

ESTOC (located 60 nm north of Las Palmas at 29°10 N, 15°30 W) was initiated in 1994 as a joint Spanish -German initiative which is funded in Germany by the ministry for research and development (BMBF). The station is sampled monthly, supplemented by current meter and sediment trap moorings at the site. As often as possible, the monthly sampling stations are covered by German vessels in conjunction with regional cruises that aim at the validation of time-series observations for the larger region.

ESTOC is also a reference station for the EU project CANIGO which started in fall of 1996. In CANIGO, researchers from 51 European institutions study the regional hydrography and water mass structure in the northern Canary Islands, Azores and Gibraltar regions, as well as particle flux and paleoceanography north of the Canaries and along the Moroccan shelf. The purpose is to obtain an integrated view of oceanographic processes in this region both in the present and of the past.

Processes along the NW African margin, especially the extended filament region off Cape Ghir ('Cape Ghir filament') may profoundly influence oceanography as well as particle flux in the open ocean region several hundreds of kilometres off the coast. In the context of the CANIGO, the Cape Ghir filament and its influence on open ocean processes has become an important issue when investigating the eastern branch of the subtropical gyre. Recent SeaWiFS satellite images have shown that the filament is not only present during the main upwelling time in fall, but also in winter. On this cruise, we studied both the extend, as well as the water column structure, new production, distribution of pigments, large particles and particle flux in different regions of the filament in the winter season. A towed, undulating CTD aided in the mapping of the structure of the filament. Real time SeaWiFS images indicated the extension of the filament and helped in determining the investigation area and ship course. Concomitantly, $p\text{CO}_2$ was determined to show the importance of the filament in changing surface concentrations of this gas.

In addition, we recovered a sound source (SQ4, IfM Kiel) east of Madeira (see map) and conducted monthly station work for February at the time-series station ESTOC, including drifting traps.

3) Narrative

Poseidon left port of Las Palmas little after 19:00 of 15 February 1999 with course to the ESTOC. Underway, a test station with the deployment of the CTD/rosette was carried out. During the morning of 16 February, station work at the ESTOC started by deploying a drifting particle trap, and continued with general station work with CTD/rosette and multinet. On 17 February we towed a shuttle carrying a CTD and optical sensors in a bow-shaped course in the vicinity of the station close to the location of the drifting trap. The drifting trap was recovered in the afternoon, and we departed the ESTOC area with course to the Cape Ghir area. On the way we deployed the shuttle again for test purposes and lowered a CTD/Rosette. On 19 February we commenced work in the Cape Ghir filament area by deploying 3 drifting traps and conducted station work with the CTD/rosette. One of the drifting traps had to be recovered on the same day as it drifted directly towards the coast. During the afternoon and during part of 20 February, the shuttle was towed in the filament. In the afternoon of 20 February we parted for the sound source mooring SQ4 which we recovered on 21 February. We then returned to the Cape Ghir area where we resumed station work in the filament area on 22 February by recovering the two traps that had been deployed there previously and by conducting CTD/rosette and a multinet cast. One of the traps had been manipulated and only the surface buoy could be recovered. Two additional traps were deployed the same day. On 23 February we conducted more station work, recovered the traps and towed the shuttle while steaming westwards in direction to the ESTOC. We conducted two CTD/rosette stations on the way to the ESTOC and reached the station during the late evening of 24 February. We deployed a drifting trap there and conducted station work with the CTD/rosette unit and with a multinet. During the day of 25 February we towed the shuttle in a bow-shaped course around the ESTOC and recovered the drifting trap in the evening of the same day. After deploying a NOAA satellite-calibration drifter we departed with course to Las Palmas. Along the way and during the same day we launched 5 XBTs. We called port of Las Palmas little after 8:00 on the morning of 26 February as scheduled.

NE Trades were quite strong during the beginning of the cruise, but decreased during the second part of the journey. Station work could be completed as planned.

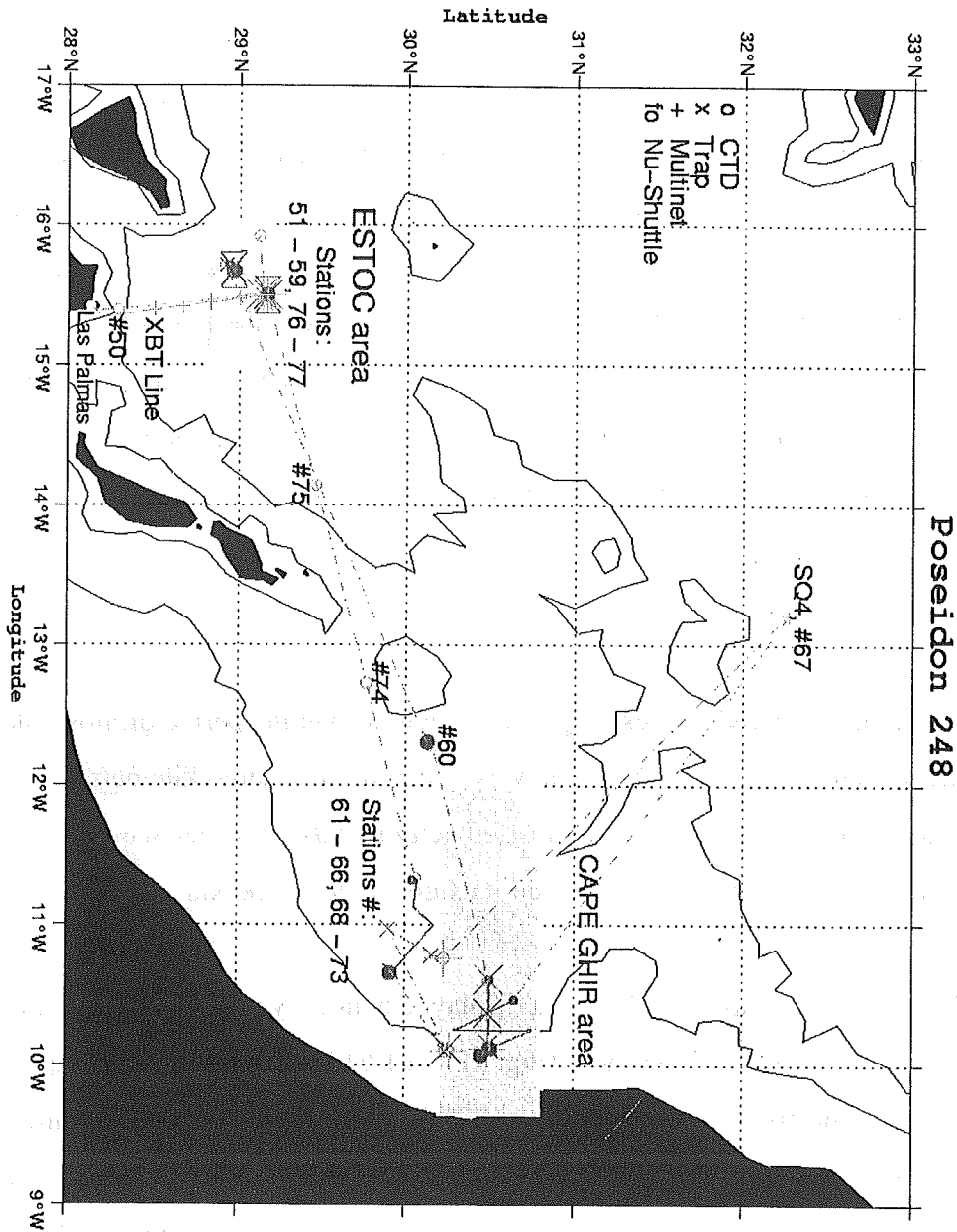


Figure 1. Cruise track, main research areas and stations covered on POS 248.

4) Scientific report and first results

4.1 Ocean Colour Images

Robert Davenport

The Sea-viewing Wide Field of View Sensor (SeaWiFS) on-board the OrbView-2 satellite was used during the cruise to provide near real-time ocean colour imagery of the CapeGhir filament region. SeaWiFS provided data every other day at 1 km resolution. Usable although poorer resolution data was retrieved on most of the other days. The data from each pass was collected by a ground station at the University of Las Palmas in Gran Canaria and processed in the University of Bremen. Images were then sent via e-mail or fax to the Poseidon the same day. During the whole period of ship operations in the region of CapeGhir from 17 February to 23 February there was more or less clear skies each day which allowed for a continuous monitoring of the chlorophyll distribution and dynamics.

Filament Structure and Dynamics

The Cape Ghir filament typically reaches its greatest extent during the period of most intense coastal upwelling in summer/autumn when it may extend several hundred kilometres offshore. Nevertheless it has been observed to show significant activity during the late winter/early spring period as for example in March 1998 when it extended up to 500 km offshore.

In February 1999 though the Cape Ghir filament displayed a more typical winter appearance being restricted to within 100 km of the shore (Fig. 2). On 12/13 February it was comprised of several E-W 'jets'. By the 16 February these 'jets' had developed into complex cyclonic eddies. On the 18 February it was clear that 'jets' were being transported southwards by the cyclonic flow. At the same time ambient chlorophyll levels were rising over the whole region possibly as a result of increased winds and better mixing of nutrients in the surface waters. This resulted in a complex pattern of chlorophyll distribution throughout the CapeGhir region and those features specifically associated with the filament were difficult to identify. By the 21 February the enhanced chlorophyll levels began to subside offshore: higher levels were restricted to the coastal upwelling region.

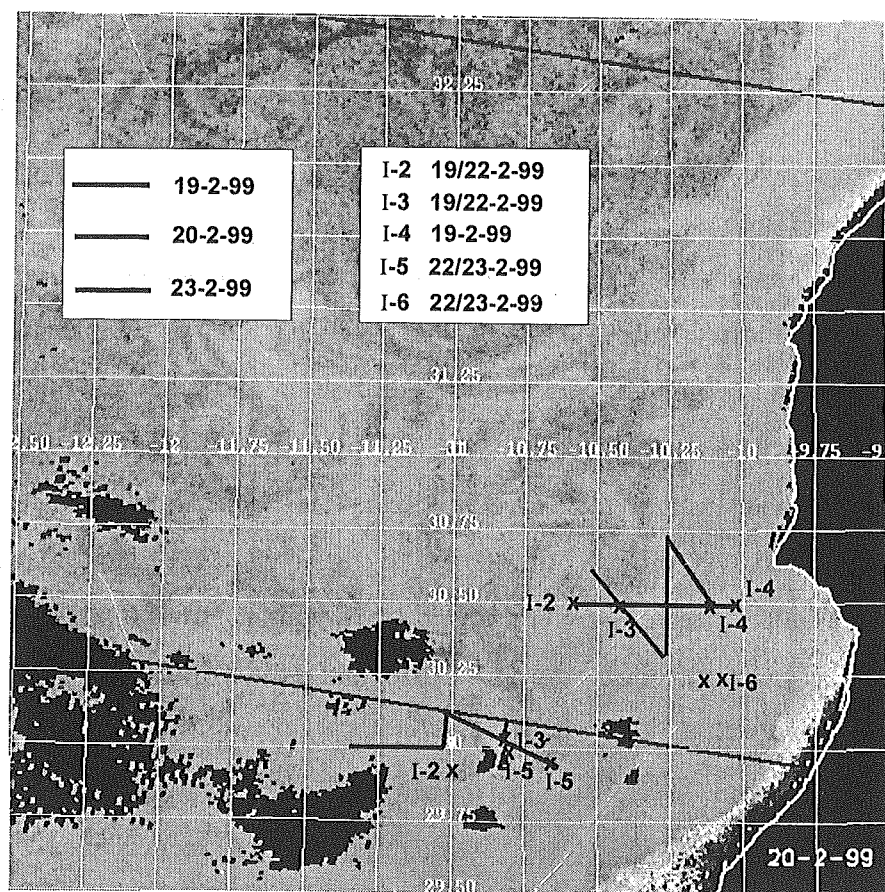


Figure 2. SeaWiFS satellite image taken on 20 February 1999 showing the high chlorophyll area along the coast due to upwelling and the complex filament structure. Shuttle tracks and drifters are overlaid.

4.2 Physical Oceanography

Bernd Lenz, Uwe Koy

Methods

Measurements with a Conductivity-Temperature-Depth (CTD) recording FSI were made near ESTOC, Cape Ghir and on a section between these working areas. A fluorometer was attached to the CTD for profiles not deeper than 3000m. The FSI-CTD was operated together with a General Oceanics rosette carrying 21x10 l Niskin bottles. For a couple of stations a Seabird CTD and a transmissometer were also attached to the rosette.

The FSI-CTD had a laboratory calibration for the temperature sensor according to the standards of the World Ocean Circulation Experiment (WOCE). Salinity samples from the Niskin bottles were taken to check the correct closing of bottles, and samples from the deep ocean in low gradient zones were taken to calibrate in-situ conductivity and salinity of the CTD. Salinity measurements were made with a Guildline AUTOSAL 8400 A. After processing, calibration and averaging to 2 dbar intervals, the accuracies of the CTD data are expected to be better than 5 dbar for pressure, better 0.002 mK and better 0.002 in salinity. The calibration and processing of the Seabird CTD data and the transmissometer is ongoing.

With a cycle of one minute the ship position with the GPS/Glonass navigational system, meteorological data, data from the ship thermosalinograph and from the echosounder were recorded. Corrections of temperature and conductivity/salinity of the thermosalinograph were conducted by comparison with CTD data and salinity samples from bottle samples taken near the surface.

First results

In the ESTOC area 8 profiles were recorded, 6 at the beginning of the cruise and 2 at the end. In Fig. 3 the positions, θ -S -relations, pot. temperature and salinity are shown for the top 300dbar. In the θ -S diagram crosses mark the 100dbar and circles the 200dbar passages. The diagrams show a nearly 150dbar deep surface layer for the first days of the cruise and a deepening up to more than 200dbar with a small jump in θ and S at 110dbars at the end of the

cruise. The diagrams of the profiles taken in the CapeGhir area (Fig. 4) indicate the wide range in θ and S depending on the location, whether the profiles were recorded in a filament (#60-#63, low temperatures and low salinities), outside of filaments (#68-#72, temperatures about 16°C and salinity 36.35, respectively) or offshore (#73, high temperature and high salinity).

A section along 30.5°C in the Cape Ghir area confirms the results from earlier cruises (M37/2, P237/3), that the isotherms and isohalines decrease towards the African coast (Fig. 5)

The continuously recorded temperature and salinity data from thethermosalinograph show the decrease in temperature (Fig. 6) and salinity (Fig. 7) towards the African Coast at the surface. Very low temperature and salinity values (blue points) indicate the filaments in the CapeGhir area.

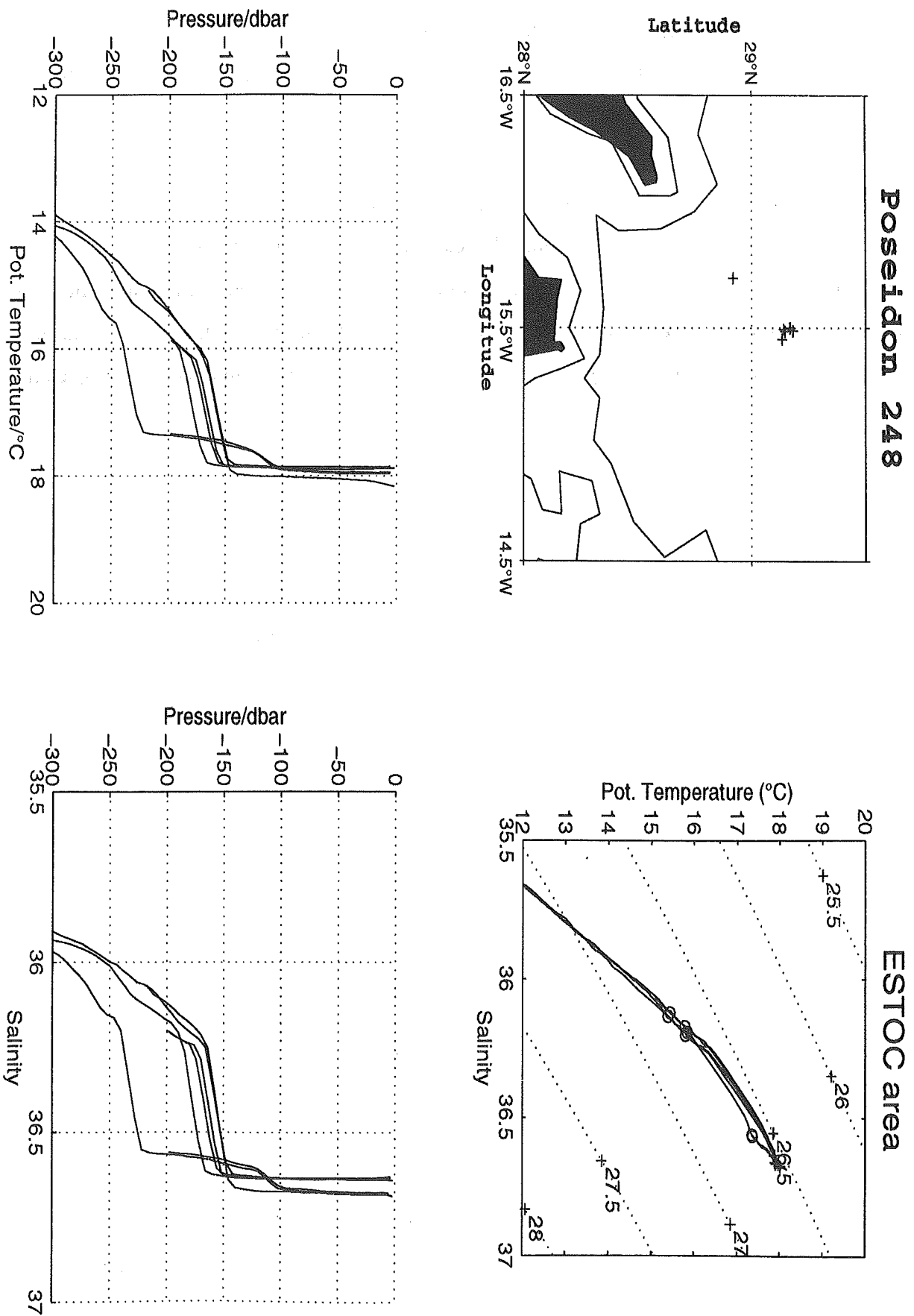
Figure 3. Positions of CTD Stations, θ -S relations, θ /P- and S/P relations at ESTOC

Figure 4. Positions of CTD Stations, θ -S relations, θ /P- and S/P relations at Cape Ghir

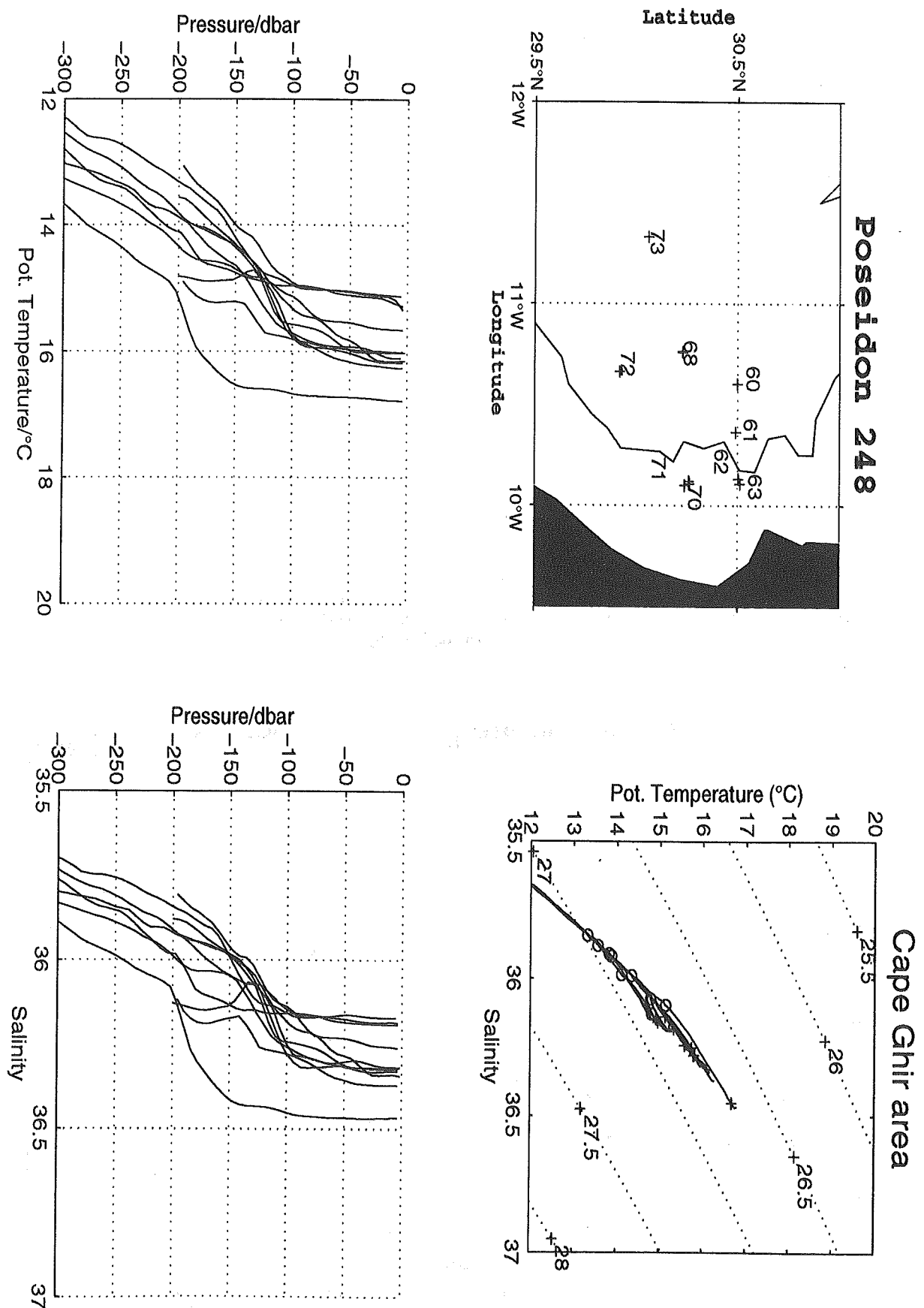
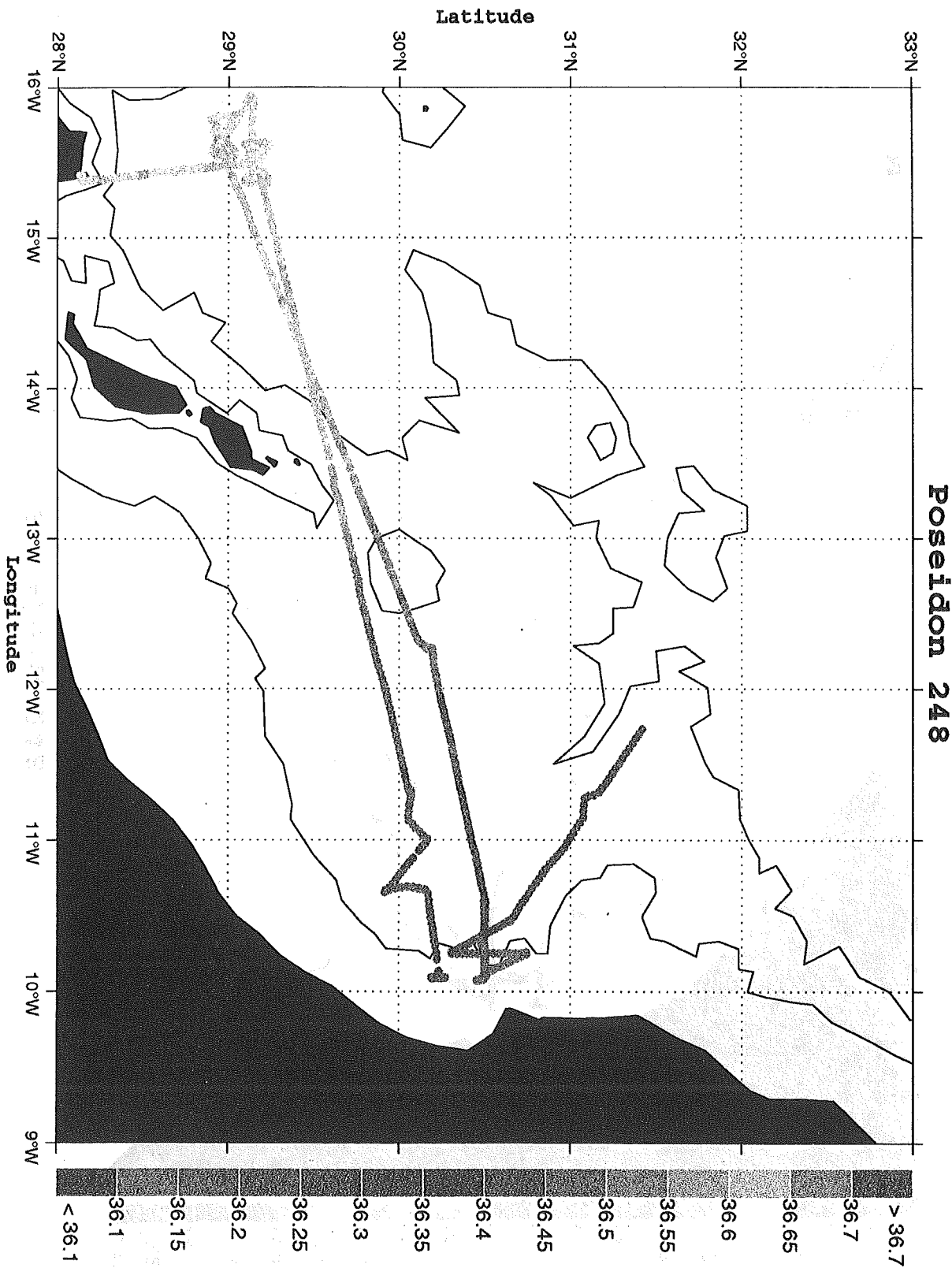


Figure 7. P248 Thermosalinograph: Salinity



4.3 *Nv-Shuttle*

Mario Manriquez, Joel Sans, Susanne Neuer

The *Nv-Shuttle* is an autonomous system that can be deployed from any ship with available deck space of 4m², ability to support 4.5t and an A-frame for the towing and handling of the cable of the shuttle.

The equipment is composed of the following components:

Hydraulic unit.

Winch and block.

Deck unit.

NvShuttle .

A. The hydraulic unit

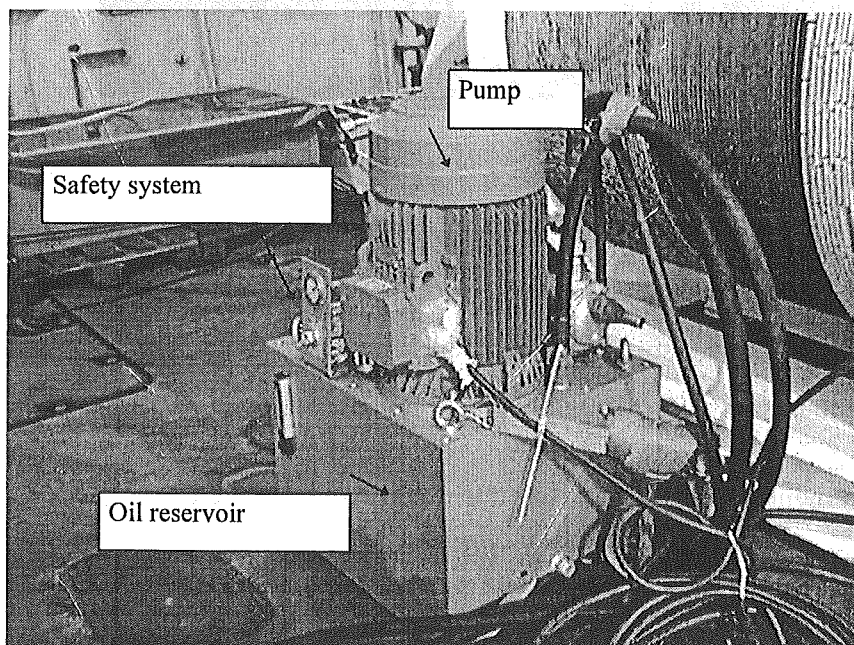


Figure 8. Hydraulic system.

The hydraulic unit (Fig. 8) is composed of an oil tank, a pump, a cooling cycle and a safety circuit where the maximum pressure can be obtained. The system is set to a pressure of 160 Bar and can maximally achieve a pressure of 180 Bar, developing a nominal power of 25CV, 18400 Watts . The system needs to be fed with a trifasic current of 380V and 50Hz.

B. Winch and block.

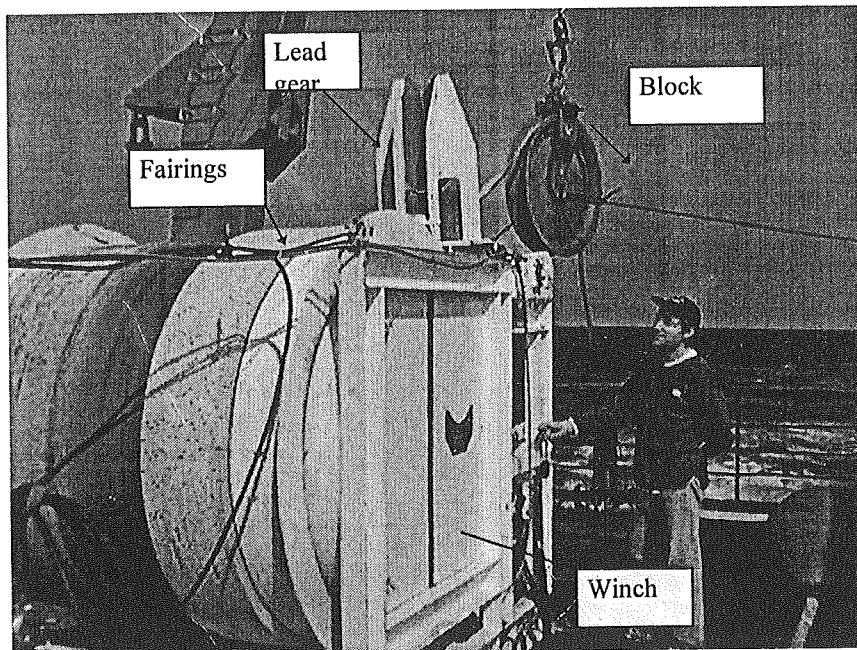


Figure 9. Winch and Block

The winch (Fig. 9) occupies an area of 2x2x2m, weighs about 4.5t and needs a high pressure hydraulic system. The multi-conducting cable is 500 m long and is wound as a single layer on the drum. The first 120 m are supplied with small wings, so called 'fairings'. Fairings are needed to lower the instrument to 150 m depth while navigating at 10 or more knots.

One of the requirements of the system is that the angle of the cable coming from the winch has an angle with the block between 7° and 14° with respect to the horizontal plane.

C. Nv-Shuttle



Figure 10. Nv Shuttle

The Nv-Shuttle (Fig. 10, 11) is a towed vehicle with which carries various oceanographic sensors that determine various oceanographic parameters underway. The sensors, the range and the precision of the parameters determined is listed below:

Pressure	0 a 200 dBar, 0.2 dBar.
Temperature	-2 a +35°C, 0.003°C.
Conductivity	1 a 70 mmho/cm, 0.005 mmho/cm.
Fluorescence	0.01 a 100 µg/l, 0.02 µg/l or 3%.
Transmisometer	0 a 5 V, < 0.3%

PAR. This sensor determines the quantity of light as a function of wave length and the units are $\mu\text{W}/\text{cm}^2$. It covers a range of 350 to 800 nm with the following precisions:

from 350 to 400 nm, 8%.

from 450 to 700 nm, +/- 3%.

from 700 to 800 nm , 8%.

Radiance & Irradiance (SeaWifs): Like the PAR-sensor, these sensors determine the quantity of light as a function of wave length with the units of $\mu\text{W}/\text{cm}^2$ between 400 y 700 nm. They are either oriented upwards, 'Upwelling Radiance Sensor' which has a field of vision of 10° with a silica photo diode area of 13 mm^2 , or oriented downwards 'Downwelling Irradiance Sensor' with a photo diode area of 17 mm^2 .

OPC (Optical Plankton Counter). This is an optical plankton counter which delivers grouped counts of digital sizes of particles in the water. These are transformed into equivalent spherical diameters with a range of 20 nm to $250 \mu\text{m}$.

Pitch & Roll. These are sensors of vital importance to the control of the navigation of the shuttle in the water column and determines the angle and the lateral inclination of the vehicle during the tow. In addition these sensors also transmit information on the position of the wing of the shuttle that determines the flight path.

In addition it is possible to include via a modem codified information in **NMEA 0183 \$GPGLL** so that with each recording (every second) Latitud and Longitud is recorded together with date and hour hour.

The movement of the shuttle is determined by the action of a servo that moves a wing in the shuttle thereby changing the angle of the flight path. The energy for this movement is obtained by an alternator which receives the necessary revolutions through a posterior helix that turns by the own movement of the shuttle through the water.

The recommended limit of sea state for the operation of the shuttle is 5-6.

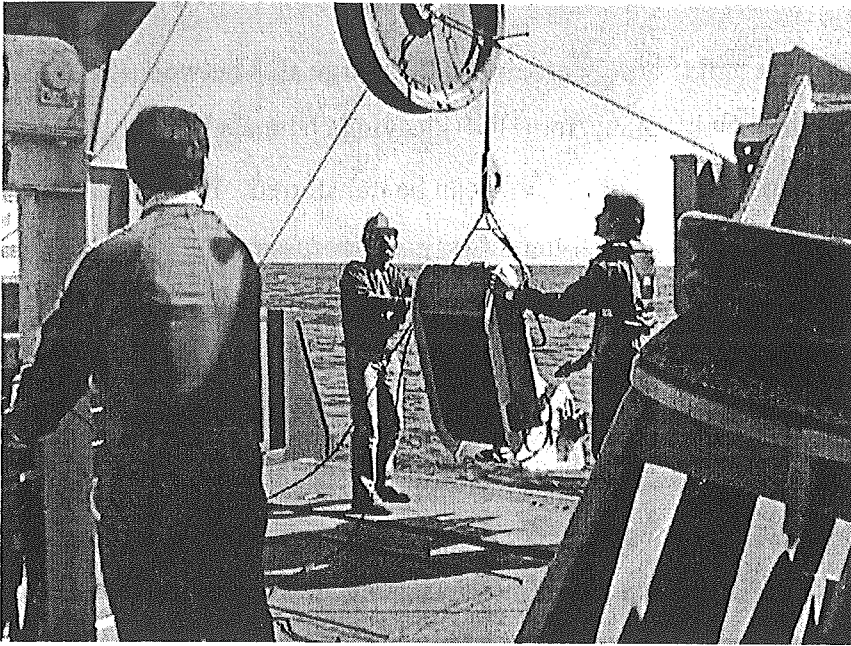


Figure 11. Handling of the Nv-Shuttle on deck.

D. Deck unit.

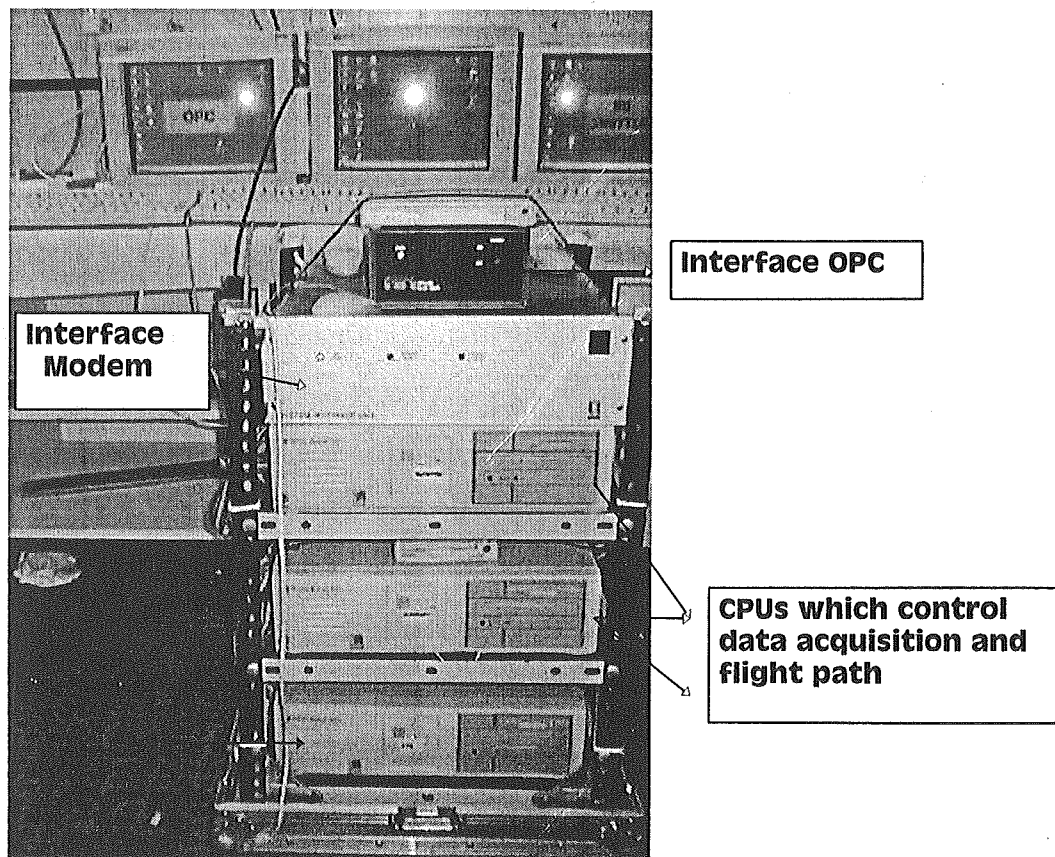


Figure 12. Deck unit with computers.

The computers of the deck unit (Fig. 12) are linked by a large area network (LAN) and connected via an 8 channel multi-connector (HUB) leaving channels free for other LANs so that files generated during operation of the *NvS* can be transferred. The software permits real-time visualisation of the parameters and after a first post-processing the files are transferred into ASCII which permits compatibility with different applications and data processing.

Deployment

During the cruise the shuttle was deployed six times, twice around ESTOC, one test track and and thrice in the Cap Ghir Filament area. Deployment data are shown in Table 1.

Table 1. Deployment data of *Nv*-Shuttle during POS 248.

Deployment					Recovery				
#	Station	Date	Time	Lat. (N) Long. (E)	Station	Date	Time	Lat. (N) Long. (E)	
1	58	02 17	08:30	28°58.2 -015°39.9	59	02 17	14:01	28°56.4 -015°42.9	
2	60	02 18	14:07	30°07.5 -012°18.2	61	02 18	14:31	30°09.3 -012° 16.7	
3	63	02 19	14.23	30°27.2 -010°04.4	64	02 19	17:39	30°30.2 -010°36.4	
4	66	02 20	08:05	30°30.5 -010°07.2	67	02 20	15:37	30°38.9 -010°27.9	
5	72	02 23	12:17	29°54.8 -010°39.3	73	02 23	17:44	30°04.3 -011°18.9	
6	76	02 25	08:00	29°10.0 -015°30.3	77	02 25	14:11	29°11.8 -015°32.5	

4.4 Nutrients, oxygen, yellow substance, salinity and dissolved aluminum

Juana Godoy, Andres Cianca

Samples for nutrients (nitrate, nitrate, phosphate, silicate) were collected in plastic bottles and frozen immediately until analysis onshore with a Skalar Scan Plus continuous flow autoanalyser. Samples for oxygen were taken in 125 ml glass bottles, fixed and titrated after precipitation (at least 6 hours after sampling) using a Metrohm 682 titroprocessor with dosimat 662 oxygen auto-titrator analyser. All analyses followed the WOCE operations manual, WHP Office Report No. 68/91. Salinity and yellow substance, an indicator of dissolved organic matter, were sampled at ESTOC in dark bottles and kept refrigerated until analysis at the ICCM laboratory. Yellow substance will be analysed with a spectrofluorometer Shimadzu RF-5301PC at an excitation length of 341nm. Salinity will be analysed using a Autosal salinometer 8400 A.

4.5 Plankton biomass

Tim Freudenthal, Susanne Neuer, Juana Godoy, Christina Hayn, M. Schroeter

Methods

The phytoplankton community was quantified in the upper 200 m at ESTOC and in the filament region. Samples were taken for chlorophyll (500 ml for regular ESTOC sampling, otherwise 2x200ml), taxonomically characteristic pigments (analysed with High Pressure Liquid Chromatography, HPLC, 2 l) and POC (Particulate Organic Carbon, 2 l) and microscopy (for epifluorescence and diatom analysis). During transit from ESTOC to the filament region, chlorophyll samples were taken also from the surface (pump situated in about 2 m depth in ships hull) every 10-20 nm. All of the water samples with the exception of the samples for microscopy were filtered on GF/F filters. While chlorophyll *a* was analysed onboard ship as an acetone extract using a Turner AU 10 fluorometer (after extracting for 24 h in the cold), POC and HPLC samples were kept frozen until analysis onshore. Samples for epifluorescence microscopy were fixed with 25% Glutaraldehyde (1 ml/50 ml sample) filtered onboard ship with 0.1 ml or 0.5 ml DAPI (concentration of DAPI: 1mg/50ml), mounted on slides with immersion oil, and kept frozen until analysis on shore. Samples for Utermöhl

microscopy (to be analysed for diatoms by group of F. Abrantes, Lisbon) were fixed with 37% buffered Formalin (2 ml/50ml sample) and kept cool until analysis.

Results

Chlorophyll *a* data show a high variability of surface water chlorophyll concentration especially in the near coastal region between -11° and -10° W (Fig. 13 a,b) probably due to the complex filament structure. However, a close correlation of chlorophyll concentration with surface water temperature was not observed.

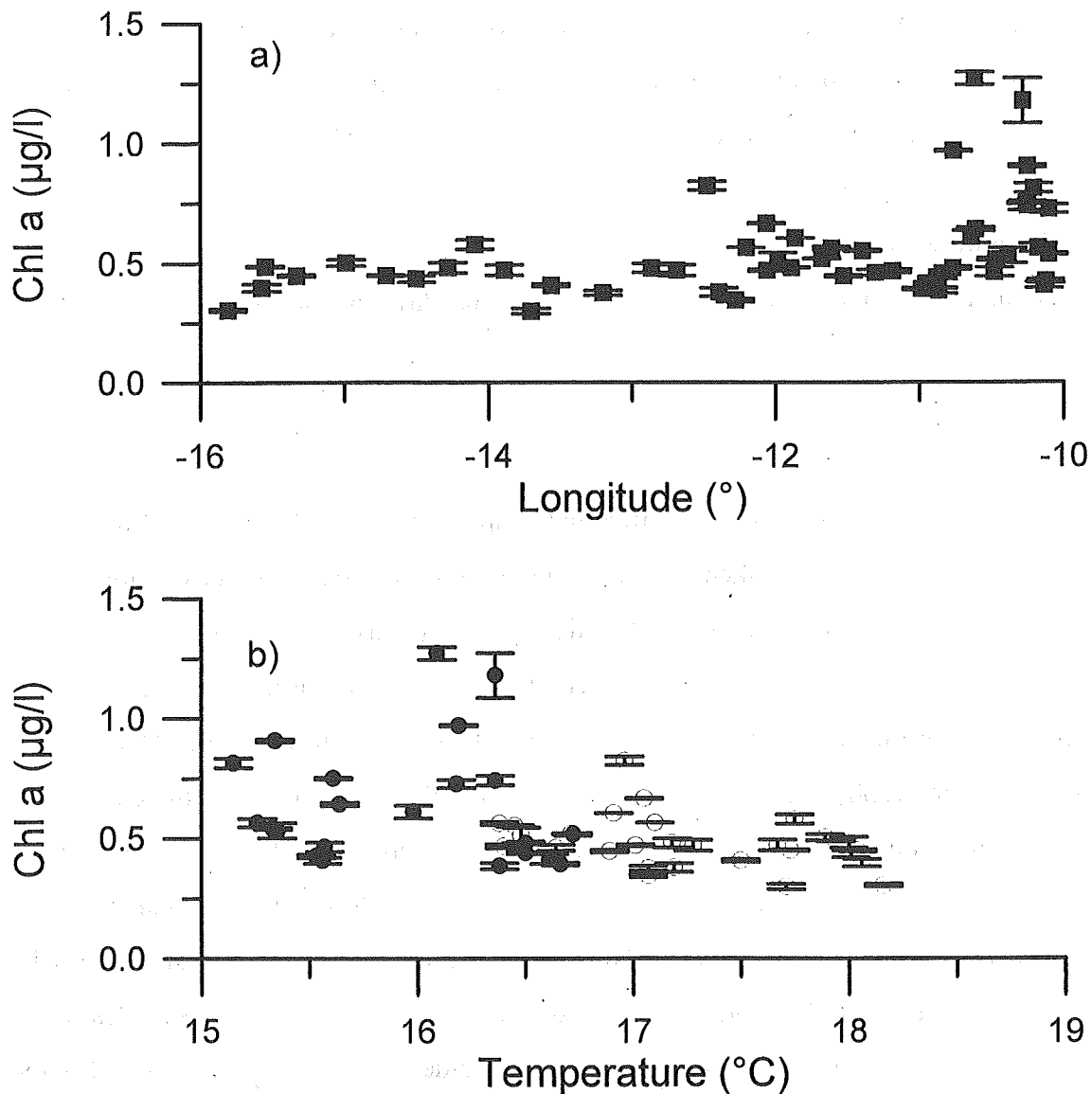


Figure 13. Surface water chlorophyll concentration compared to Longitude (a) and sea surface water temperature (b); open circles mark stations west of -11° , filled circles mark stations east of -11° .

The depth distribution of chlorophyll showed rather constant values of about $0.3 - 0.4 \mu\text{g/l}$ in the euphotic zone at ESTOC (Fig. 14). This is indicative for deep turbulent mixing typical for winter months. Depth distribution at the filament showed as well rather constant but higher concentrations compared to ESTOC. The characteristics of the water masses changed during drifting experiments towards more stratified conditions.

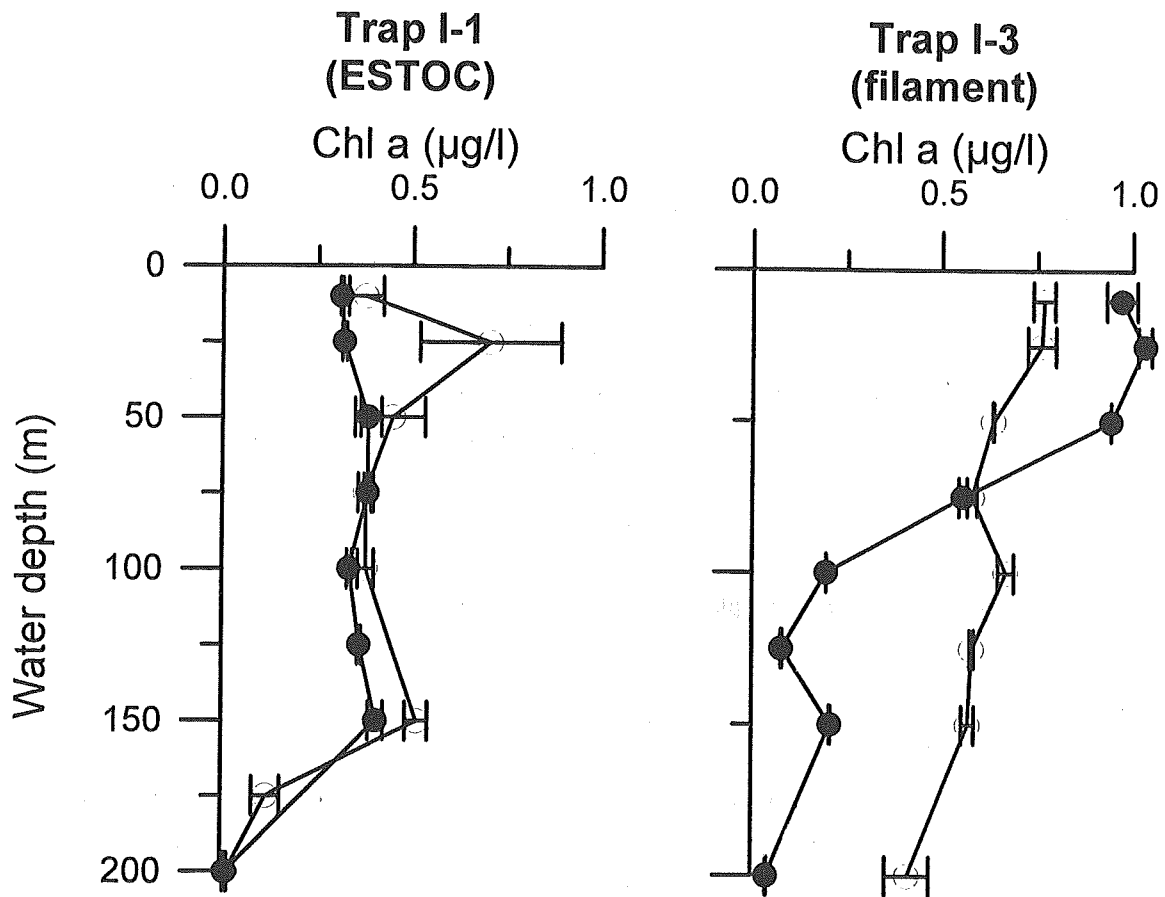


Figure 14: Chlorophyll concentration profiles during start (open circles) and end (filled circles) of drifting trap experiments

4.6 Stable nitrogen isotopes of dissolved nitrate

Tim Freudenthal

Water samples for the measurement of stable nitrogen isotope ratios of dissolved were taken in order to investigate the stable nitrogen isotope ratio of deep water nitrate and the fractionation during assimilation. For each sample about 1l of sea water was filtered and stored frozen. Five samples were taken from water depths 3000 m and 1200 m at station 53 and 600 m, 400 m, and 200 m at station 54 (both ESTOC).

4.7 Particle sampling using a multiple closing net

Tim Freudenthal

Particles were sampled with vertical hauls of a multiple closing net (HYDROBIOS) with 0.25 m² opening and 64 µm mesh size. It was deployed on 5 sites (Table 2).

Table 2: Sampling sites and depth for multiple closing net deployments

GeoB #	Poseidon #	Latitude	Longitude	Water depth (m)	Sampling intervals
5606-1	56	29°08,45	15°29,78	3608	2000-1200, 1200-800, 800-500, 500-200, 200-0m
5614-1	65	30°30,52	10°07,09	462	400-200, 200-100, 100-50, 50-10, 10-0m
5615-2	68	30°13,74	10°45,75	1857	400-200, 200-100, 100-50, 50-10, 10-0m
5617-4	70	30°15,97	10°06,045	458	350-200, 200-100, 100-50, 50-10, 10-0m
5623-3	76	29°10,09	15°29,86	3607	400-200, 200-100, 100-50, 50-10, 10-0m

The samples were carefully rinsed with seawater into KAUTEX bottles while sieving through a 1 mm sieve. They were fixed with mercury chloride and stored at 4°C. Samples will be used for the study of planktonic foraminifers and for geochemical analysis.

4.8 Phytoplankton production rates

Susanne Neuer, Juana Godoy, Christina Hayn

Phytoplankton primary production was determined by dilution experiments and by the change of oxygen during incubation. Experiments were incubated for 24 h with water from 25 and 75 m at ESTOC (STA 55), 25 m (STA 76) and 10 m and 50 m at the filament station (STA 70) in an on-deck incubator during 24 h, always starting at dawn or at night. Light-levels at depths were simulated with neutral density screens, and the incubator was cooled with flowing surface sea-water.

The principle of the dilution experiments is based on the incubation of different dilutions of natural sea-water in 1 l poly-carbonate bottles. Phytoplankton growth and microzooplankton grazing rates can be determined from the change of chlorophyll in the different dilutions by linear regression of the apparent growth rate in each dilution on dilution factor.

O₂ - incubations were carried out under the same conditions, with the change of oxygen (for methods see 4.4) determined in light and dark bottles of 250 ml volume. Incubation in the on-deck incubator lasted either 12 h (between dawn and dusk) or 24 h over a diel cycle. The change of oxygen in the dark bottles is due to respiration by the whole plankton community. The change in the light bottles reflects the production of oxygen by photosynthesis minus the loss due to respiration, and represents the net photosynthetic rate of the phytoplankton community. Gross photosynthesis can be determined by adding the loss of oxygen (calculated as hourly rate) due to respiration as determined from the dark bottles.

4.9 The use of stable nitrogen and carbon isotopes to measure primary production

Marcel Schroeter

Introduction

Primary production, the uptake and assimilation of CO₂ by autotrophic plankton, can be divided into new and regenerated production. New production is based on the uptake of new nutrients (e.g. nitrate) that originate from outside the euphotic zone by processes such as

upwelling or mixing. On the other hand, regenerated production is defined as a primary production fuelled by nutrients recycled in the productive euphotic zone, such as ammonia excreted by heterotrophic organisms. New production eventually has to be exported as sedimenting particles (export production) to maintain a mass balance in the upper productive layers. The Pos 248 cruise track covered distinct nutrient regimes, from oligotrophic (ESTOC, north of Gran Canaria) to eutrophic regions, close to the NW African upwelling system (Cap Ghir filament). The aim of this study was to correlate the uptake and incorporation of $^{15}\text{N-NO}_3$ and $^{13}\text{C-HCO}_3$ by phytoplankton to new and total primary production, respectively.

Methods

Discrete water samples were collected before dawn from nine optical depths (116, 93, 83, 53, 39, 21, and 8m), corresponding to 0.1, 0.5, 1, 6, 13, 34 and 52% of surface irradiance, respectively, to achieve a high resolution of the euphotic zone. Samples were incubated in bottles covered with neutral density filters of the corresponding light intensity on board (simulated *in-situ* incubation). Stable isotopes ($^{15}\text{NO}_3$ and H^{13}CO_3) were added in trace concentrations in order to maintain the natural nutrient abundance. After about 12h, the experiments were stopped by filtering the samples onto precombusted GF/F filters. The incorporated isotopes and the particulate nitrogen and carbon contents (PON and POC) will be determined by mass spectrometry and elemental analyses in the laboratory. To normalise the primary production rates to biomass, samples for chlorophyll a and other phytoplankton pigments were taken for fluorometric and liquid chromatographic analyses. Production and chlorophyll samples were size-fractionated using 5 μm polycarbonate filters.

First results

Profiles of primary production were taken at five stations (St. 57, 61, 68, 71 and 76). St. 57 and 76 (ESTOC) were characterised by deep chlorophyll maxima, whereas the chlorophyll maxima were at the surface in the Cap Ghir region (St. 61, 68 and 71). The phytoplankton was dominated by ultraplankton (<5 μm).

4.10 Carbon dioxide in sea-water

Melchor González-Dávila

In response to increased interest in global climate change and greenhouse warming, measurements of the marine carbon system (i.e. total CO_2 , TCO_2 , titration total alkalinity TA, pH and pCO_2) have been included in several global research programs such as the World Ocean Circulation Experiments (WOCE) and the Joint Global Ocean Flux Study (JGOFS). These programs include time series stations primarily designed to examine temporal variability and the mechanism controlling this variability. The Canary Islands Time series (ESTOC) is visited each month and the surrounding area approximately twice a year. Time series station data provide excellent opportunities to study the temporal variability of the carbon system at a single location over several years, while cruises around the ESTOC station will provide information about spatial variability of the carbon species in the area.

During this cruise parameters of the carbonate system (pH and total alkalinity) were collected at ESTOC (STA 76). Underway pCO_2 measurements using an automated system were carried out continuously during the cruise. Fugacity of carbon dioxide (fCO_2) in air and in surface seawater was determined with a flowing system similar to the one designed by Wanninkhof and Thoning (1993) and developed by Frank J. Millero's group at the University of Miami. The equilibrator used is based on the design described by Weiss (1981). The concentration of CO_2 in the air and in the equilibrated air sample is measured with a differential, non-dispersive, infrared gas analyser supplied by LI-COR (LI-6262 $\text{CO}_2/\text{H}_2\text{O}$ Analyser). The samples are measured wet and the signal corrected for water vapour using the water channel of the LI-COR. The instrument is operated in the absolute mode and gathers CO_2 concentrations directly from the instrument. The LICOR analyses the concentration of CO_2 in the instrument every 6 s, averages these values over a 1-min interval, and records them. Atmospheric air is pumped at the bow of the ship and measured every hour. The system was calibrated by measuring two different standard gases with mixing ratios of 348.55 and 520.83 ppm CO_2 in air. These calibrated standards were provided by NOAA Institution and they are traceable to the WMO (World Meteorology Organisation) scale. Our system has a precision of less than 2 μatm and is thought to be accurate, relative to the standard gases to 3 micro atm.

Fugacity of CO₂ in the seawater was calculated from the measured XCO₂ (mole fraction of CO₂ gas corrected to dry air and to the pressure of 1 atm)

Wanninkhof, R., Thoning, K., 1993. Measurement of fugacity of CO₂ in surface water using continuous and discrete sampling methods. *Mar. Chem.*, 44, 189-204

Weiss, R.F., 1981. Determination of CO₂ and methane by dual catalyst flame ionization chromatography and nitrous oxide by electron capture chromatography. *J. Chromatogr. Sci.*, 19, 611-616.

4.11 Particle flux measurements with drifting particle traps

Susanne Neuer, Tim Freudenthal, Uwe Koy

Drifting trap experiments were carried out to determine particulate carbon flux that originates directly from the euphotic zone. These rates are then interpreted in the context of measurements of the standing stock and production rates of the plankton community in the euphotic zone.

To study particle flux below the euphotic zone, surface-tethered particle interceptor arrays were deployed north-east of the ESTOC station and in the Cape Ghir filament (Table 3), with one trap at 200 m depth (Trap I, Fig.15). The traps were attached to a surface buoy carrying an ARGOS transmitter and a Radar reflector. The main buoyancy was located at about 30 m depth to avoid the wind-induced EKMAN layer.

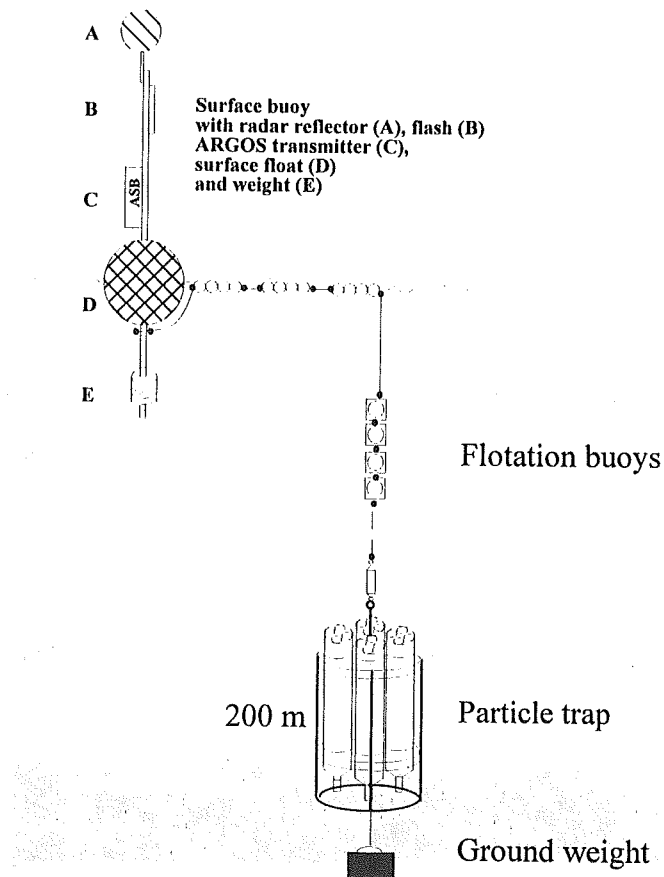


Figure 15. Drifter I carrying one trap at 200m depth.

Table 3. Deployment data of drifting traps during POS 248.

Deployment					Recovery				
#	Station	Date	Time	Lat. (N) Long. (E)	Station	Date	Time	Lat. (N) Long. (E)	
I-1	51	02 16	06:32	29°07.8 -015°30.2	59	02 17	14:25	28°55.3 -015°42.9	
I-2	61	02 19	07:14	30°29.7 -010°36.8	69	02 22	14:24	29°54.0-010°58.4	only buoy
I-3	62	02 19	08:40	30°29.6 -010°22.3	68	02 22	12:10	30°09.4-010°47.2	
I-4	63	02 19	12:55	30°30.0 -010°08.8	64	02 19	20:24	30°30.8-010°06.7	
I-5	68	02 22	12:30	30°09.1 -010°47.0	72	02 23	11:33	29°55.2-010°39.9	
I-6	70	02 22	20:20	30°14.9 -010°06.9	71	02 23	06:00	30°14.3-010°06.0	
I-7	76	02 24	22:55	29°09.9 -015°29.9	77	02 25	17:30	29°09.5-015°29.8	

First results

All but trap I-2 could be recovered successfully. I-2 was obviously manipulated and only the surface buoy could be recovered. The drifters deployed closest to shore (I-4, I-6) drifted towards the coast, the others towards the south (Fig. 16). Drifting speeds were usually greater in the filament region compared to ESTOC (Table 4). This might indicate that the traps were caught in eddies which are commonly observed in the filament region.

Table 4. Distance and drifting speed of the different drifters deployed during POS248. For drift course of I-2 to I-6 see Figure 16.

Drifter	Deployment period	Hours Deployed	Distance km	Speed cm/s
I-1	16.2-17.2	32	32.35	28.1
I-2	19.2-22.2	79	141.6	49.8
I-3	19.2-22.2	75.5	80.70	29.7
I-4	19.2-19.2	7.5	4.59	17
I-5	22.2-23.2	23	36.88	44.5
I-6	22.2-23.2	9.5	2.65	7.7
I-7	24.2-25.2	18.5	0.69	1.0

POSEIDON 248

Drifting Sediment Traps in the Cape Ghir Area

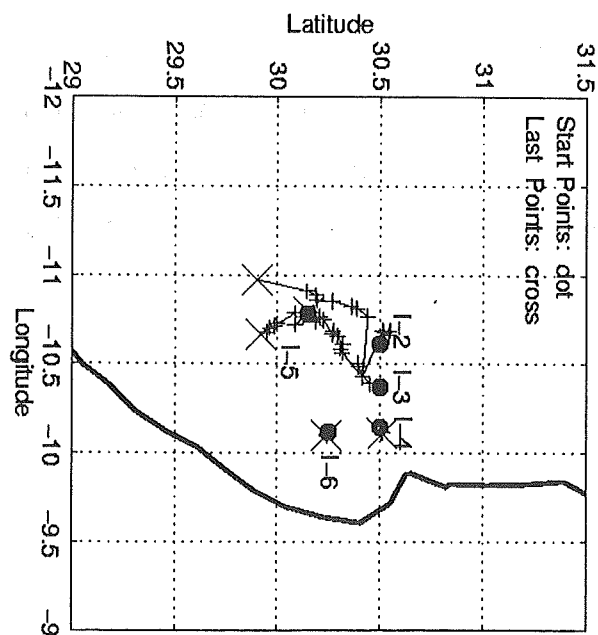
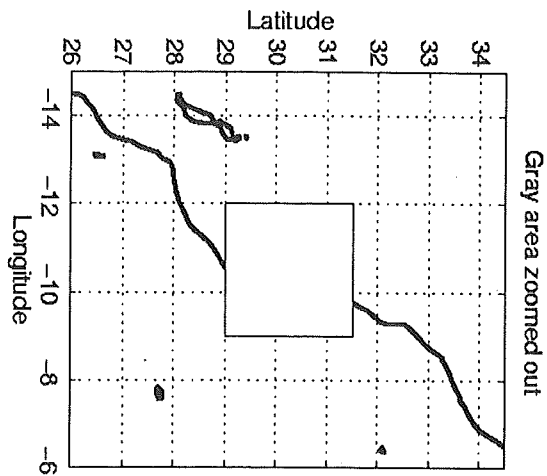


Figure 16. Drift course of drifters deployed during POS248 in the Cape Ghir filament area.

4.12 Sound source mooring

Thomas Müller, Uwe Koy, Bernd Lenz

Within CANIGO, the pathways of the Azores Current are studied using Lagrangian measurement with RAFOS-type floats which had been deployed to a nominal depth of 500 m depth west of Madeira and south of the Azores during a summer cruise on THALASSA in 1997. To track these floats, an array of four sound sources was used north, west, south and east of Madeira. The one east of Madeira had been moored at site SQ4 (32° 16.0' N, 013° 12.4' W) on 17 January 1997 during METEOR cruise 37/2b. It was recovered on 21 February 1999 without technical problems. The sound source was tested on deck after recovery; it worked correctly and was switched off by software.

Nine of ten floats have surfaced on time since January. Detailed tracks are still under processing. Floats 422 and 423 were launched in and north of the Azores Front. They drifted eastwards and they surfaced well before they reached the continental break. Float 418 was launched in the southern part of the front. On average, it drifted eastward until Madeira and then turned south. Float 419 was the most stagnant one while the southernmost, float 420, drifted south-eastward at low speeds from the beginning on. On the whole, these preliminary tracks are consistent with the view we presently have of the general circulation scheme in the northern Canary Basin. Further analysis together with CANIGO partners will provide basic flow statistics.

5) Concluding remarks

We would like to thank Captain Matthias Gross and his crew for the very competent help at sea and the pleasant working atmosphere. We are grateful to the Institut für Meereskunde in Kiel for providing the ship-time on FS 'Poseidon'. Dr. Octavio Llinas and the UGBO (Unidad Gestion de Buques Oceanograficas) group in Barcelona made the Nu-Shuttle available for this cruise. We are also grateful to Dr. Llinas and his group at the Instituto Canario de Ciencias Marinas in Telde, Gran Canaria, for invaluable logistic help in Las Palmas.

We further note the efficient collaboration with the ship's agents Flick Canarias in the port of Las Palmas, especially Ms. Evelyne Jüptner.

The satellite images were created from ground station data collected by Dr. Francisco Eugenio Gonzalez, EUITT (Universidad de Las Palmas de Gran Canaria). Data production and distribution were provided respectively by the SeaWiFS Project (Code 970.2) and the Distributed Active Archive Center (Code 902) at the Goddard Space Flight Center, Greenbelt, MD 20771 and was sponsored by NASA's Mission to Planet Earth Program. This research was funded by the EU-project CANIGO (MAS3-PL95-0443).

6) Station lists

List of abbreviations:

Alk.	Alkalinity
Chl	Chlorophyll a
CI	Canary Islands
CTD	Conductivity, Temperature, Depth sensor
B	Bottle data
Dil. Exp.	Dilution experiment to determine phytoplankton growth and microzooplankton grazing rates
Dünung,	Long period surface waves
ESTOC	European Station for Time-Series in the Ocean, Canary Islands
HPLC	Pigment samples to be analysed with High Pressure Liquid Chromatography
Lat N	Latitude North
Lon W	Longitude West
NB	Neil Brown CTD
NOAA	National Oceanographic and Atmospheric Administration
Nut	Nutrients
O ₂	Oxygen
O ₂ -Incub.	Incubation to determine oxygen change during incubation
POC	Particulate Organic Carbon
PP	Particle Pump
Prof.	Profile
SBE	SeaBird CTD
See	Sea state
Sta.	Station
uw.	Under way
XBT	Expendable Bathythermograph
18O/13C	Stable oxygen and carbon isotope ratio
N15	Stable nitrogen isotope ratio

6.1 Listing of parameters sampled

Date	Sta.	Prof.	Lat N Lon W	Weather	depth /m	time start (UTC)	ctd	sampling depth /m	O ₂	Alk/ pH	Chl std ICCM	Chl GeoB	Sal.	Nut	Mic	Gelb stoff	POC	N15	MN	Dil-Exp. O ₂ -Incub	N15 Incub (+HPLC, Chl, Nut)	Moorings Shuttle Free- floating traps
15.02.	50	1	28°17.3 15°23.8	NE 5-6 Cloudy	2907	21:04	FSI	test														
16.02.	51		29°07.76 15°30.22	NE 6-7 Cloudy	3609	06:32																
16.02.	52	2	29°08.0 15°27.1	NE 6-7 Cloudy	3605	07:02	FSI	200,175, 150,100,75, 50,25,10				#									150, 75,10 fraction. chl	
16.02.	53	3	29°09.99 15°29.93	NE 6 Cloudy	3610	13:00	FSI	3662,3500, 3000,2800, 2500,2200, 2000,1800, 1500,1300, 1200,1100, 1000,10	#				3662, 10	#			3662, 3000, 2500, 2000, 1100, 1000	3000, 1200				
16.02.	54	4	28°08.84 15°29.12	NE 6 Cloudy	3610	17:27	FSI	800,600, 400,300, 200,150, 125,100,75, 50,25,10	#		200, 150, 125, 100, 75,50, 25,10			#			800, 600, 400, 200					
16.02.	55	5	29°08.49 15°29.61	NE 6 Cloudy	3608	19:37	FSI	100,75,25, 10	75 25			#								75,25		
16.02.	56		29°08.45 15°29.78	NE 5 Cloudy	3608	20:42													2000, 1200, 800, 500, 200			
17.02.	57	6	29°07.03 15°55.26	NE 4 Cloudy	3625	05:35	FSI	150,116,93, 83,53,39,21,8													#	

Date	Sta.	Prof.	Lat N Lon W	Weather	depth /m	time start (UTC)	ctd	sampling depth /m	O2	Alk/ pH	Chl std ICCM	Chl GeoB	Sal.	Nut	Mic	Gelb stoff	POC	N15	MN	Dil-Exp. O2-Incub	N15 Incub (+HPLC, Chl, Nut)	Moorings Shuttle Free- floating traps
17.02.	58		28°58,20 15°39,96	NE 4 Cloudy	3610	08:30																deploy shuttle
17.02.	58		28°56,1 15°43,5	NE 4-5 Cloudy	3613	13:50																recover shuttle
17.02.	59		28°55,33 15°42,86	NE 4-5 Cloudy	3615	14:25																drifting trap, I-1 recover
17.02.	59	7	28°55,11 15°42,81	NE 4-5 Cloudy	3612	14:47	FSI SBE19 TRANS	200,150, 125,100,75, 50,25,10				#										
18.02.	60		30°07,50 12°18,21	NNE 6 Cloudy	1862	14:00																shuttle
18.02.	60	8	30°09,35 12°16,73	NNE 6 Cloudy	1922	14:41	FSI SBE19 TRANS	1944,500, 250,200, 150,125, 100,75,50, 25,									250, 200, 150, 125, 100, 75,50, 25				water for traps	
19.02.	61	9	30°29,94 10°36,19	E 4 Cloudy	2236	04:38	FSI SBE19 TRANS	2000,1800, 1500,1300, 1200,1100, 1000,800, 600,400, 300,200, 150,125, 100,75,50 25,10	#			200, 150, 125, 100, 75, 50, 25, 10	2000	#			2000, 1500, 1200, 1000, 800, 400, 200, 100, 50,10					
19.02.	61		30°29,7 10°36,8	E 3 Cloudy	2257	07:14																drifting trap, I-2 deploy
19.02.	62		30°29,6 10°22,3	E 2 Partly clouded	1901	09:05																drifting trap, I-3 deploy
19.02.	62	10	30°29,39 10°21,86	E 2 Partly clouded	1957	09:26	FSI SBE19	1900,1800, 1500,1300,	#			200, 150,	1900, 10	#				1900, 1500,				

Date	Sta.	Prof.	Lat N Lon W	Weather	depth /m	time start (UTC)	ctd	sampling depth /m	O ₂	Alk/ pH	Chl std ICCM	Chl GeoB	Sal.	Nut	Mic	Gelb stoff	POC	N15	MN	Dil-Exp. O ₂ -Incub	N15 Incub (+HPLC, Chl, Nut)	Moorings Shuttle Free- floating traps
							TRANS	1200,1100, 1000,800, 600,400, 300,200, 150,125, 100,75,50 25,10				125, 100, 75, 50, 25, 10					1200, 1000, 800, 400, 200, 100, 50,10					
19.02.	63		30°29,99 10°08,84	E 2 Blue sky	636	12:55																
19.02.	63	11	30°30,14 10°07,88	N 3 Blue sky	527	13:05	FSI SBE19 TRANS	484,400, 300,200, 150,125, 100,75,50, 25,10	#			200, 150, 125, 100, 75, 50, 25, 10	484, 10	#	150, 100, 50, 25,10		484, 400, 200, 100, 50, 10					drifting trap, I-4 deploy
19.02.	63		30°27,19 10°04,41	N 3 Blue sky	360	14:23																deploy shuttle
19.02.	63		30°30,23 10°36,38	N 4 Cloudy	2027	17:39																recover shuttle
19.02.	64		30°30,78 10°06,67	NE 4 Cloudy	479	20:24																drifting trap, I-4 recover
19.02	64	12	30°30,63 10°06,52	NE 4 Cloudy	447	20:39	FSI SBE19 TRANS	200,150, 125,100, 75,50,25, 10			#											
20.02	65		30°29,67 10°07,09	SE 3 Cloudy	462	06:22													400, 200, 100, 50, 10			
20.02	66		30°30,52 10°07,18	ENE 3 Cloudy	503	08:05																deploy shuttle

Date	Sta.	Prof.	Lat N Lon W	Weather	depth /m	time start (UTC)	ctd	sampling depth /m	O2	Alk/ pH	Chl std ICCM	Chl GeoB	Sal.	Nut	Mic	Gelb stiff	POC	N15	MN	Dil-Exp. O2-Incub	N15 Incub (+HPLC, Chl, Nut)	Moorings Shuttle Free- floating traps
20.02	66		30°38 10°27,5	NNE 5 Cloudy	1848	15:30																recover shuttle
21.02	67		32°15,49 13°12,73	NE 6 Cloudy	not available	09:36																release of mooring SQ4
21.02.	67		32°16,1 13°12,8	NE 6 Cloudy	not available	10:15																recover mooring SQ4
22.02.	68	13	30°13,71 10°45,88	NE 6 Cloudy	1863	06:42	FSI SBE19 TRANS	150, 116,93, 83,53,39,21, 8													#	water for traps
22.02.	68		30°13,74 10°45,75	NE 6 Cloudy	1857	07:59													400, 200, 100, 50, 10			
22.02.	68	14	30°13,69 10°45,47	NE 6 Cloudy	1805	09:11	FSI SBE19 TRANS	1772,1500, 1300,1150, 1000,800, 600,400, 300,200, 150,125, 100,75,50, 25,10,	#			200, 150, 125, 100, 75, 50, 25, 10	1772, 10	#	150, 100, 50, 25,10	1772, 1500, 1150, 1000, 800, 400, 200, 100, 50,10					water for traps	
22.02.	68		30°09,4 10°47,2	NE 6 Cloudy	1722	12:10																drifting trap 1-3 recovered
22.02.	68		30°09,1 10°47,0	NE 6 Cloudy	1720	12:30																drifting trap 1-5 deployed

Date	Sta.	Prof.	Lat N Lon W	Weather	depth /m	time start (UTC)	sampling depth /m	O2	Alk/ pH	Chl std ICCM	Chl GeoB	Sal.	Nut	Mic	Gelb stiff	POC	N15	MN	Dil-Exp. O2-Incub	N15 Incub (+HPLC, Chl, Nut)	Moorings Shuttle Free- floating traps
22.02.	69		29°54,0 10°58,4	NE 5 Cloudy	1724	14:24															drifting trap I-2 , only top buoy recovered
22.02.	70		30°14,90 10°06,91	NNE 5 Cloudy	464	20:20															drifting trap I-6 deployed
22.02.	70	15	30°15,53 10°07,16	N 6 Cloudy	489	20:34	464,400, 300,200, 150,125, 100,75,50, 25,10	#		200, 150, 125 100, 75, 50, 25, 10		#	150, 100, 50, 25, 10		464, 200, 100, 50,10				200, 125, 100, 75, 50, 25, 10 HPLC		
22.02.	70	16	30°15,77 10°06,49	NE 5 Cloudy	477	21:56	50,10											#			
22.02.	70		30°15,97 10°06,05	NE 5 Cloudy	458	22:42												350, 200, 100, 50, 10			
23.02.	71		30°14,31 10°05,98	SE 3 Cloudy	435	06:00															drifting trap I -6 recovered
23.02.	71	17	30°14,31 10°05,98	SE 3 Cloudy	435	06:15	200,150, 125,116, 100,93,83, 75,53,50,39, 25,21,10,8				200, 150, 125, 100,75, 50, 25, 10								150, 116, 93,83,53, 39,21,8	water for drifting traps	

Date	Sta.	Prof.	Lat N Lon W	Weather	depth /m	time start (UTC)	ctd	sampling depth /m	O2	Alk/ pH	Chl std ICCM	Chl GeoB	Sal.	Nut	Mic	Gelb stoff	POC	N15	MN	Dil-Exp. O2-Incub	N15 Incub (+HPLC, Chl, Nut)	Moorings Shuttle Free- floating traps
23.02.	72		29°55,25 10°39,87	NNE 5 Sky partly clouded	1441	11:33																drifting trap 1-5 recovered
23.02.	72	18	29°55,08 10°39,74	NNE 5 Sky partly clouded	1434	11:44	FSI SBE19 TRANS	200,150, 125,100, 75,50, 25,10			#											
23.02	72		29°54,83 10°39,33	NNE 5 Sky partly clouded	1422	12:17																deploy shuttle
23.02	73			N 6 Cloudy		17:40																recover shuttle
23.02.	73	19	30°03,61 11°19,77	N 6 Cloudy	2032	17:52	FSI SBE19 TRANS	2039,2000, 1800,1500, 1300,1200, 1100,1000, 800,600, 400,300, 200,150, 125,100, 75,50,25,10	#		200, 150, 125, 100, 75, 50, 25, 10	2039, 10	#	150, 100, 50, 25, 10		2039, 1800, 1300, 1100, 800, 600, 400, 200, 100,50, 10						
24.02.	74	20	29°45,65 12°43,73	NNE 4 Cloudy	1612	03:30	FSI SBE19 TRANS	1623,1500, 1300,1200, 1100,1000, 800,600, 400,200, 150,125, 100,75,50, 25,10	#		200, 150, 125, 100, 75, 50, 25, 10		#			1623, 1300, 1100, 800, 600, 400, 200, 100, 50,10						
24.02.	75	21	29°27,61 14°08,47	NE 5 Overcast sky	3370	12:37	FSI	3000,2500, 2000,1800, 1500,1300, 1150,1000, 800,600, 400,300,	#		200, 150, 125, 100, 75, 50,	3000, 10	#			3000, 2000, 1500, 1150, 800, 400,						

Date	Sta.	Prof.	Lat N Lon W	Weather	depth /m	time start (UTC)	ctd	sampling depth /m	O2	Alk/ pH	Chl std ICCM	Chl GeoB	Sal.	Nut	Mic	Gelb stoff	POC	N15	MN	Dil-Exp. O2-Incub	N15 Incub (+HPLC, Chl, Nut)	Moorings Shuttle Free- floating traps
								200,150, 125,100,75, 50,25,10				25, 10					200, 100, 50,10					
24.02.	76		29°09,92 15°29,93		3609	22:55																Trap I-7 deployed
24.02.	76	22	29°10,81 15°29,26		3609	23:13	FSI	3663,3500, 3000,2800, 2500,2000, 1800,1500, 1300,1200, 1100,1000, 800,600, 400,300,10	#	#				#								
25.02.	76	23	29°10,23 15°30,00		3608	03:46	FSI	200,150, 125,116, 100,93,83, 75,53,50, 39,25,21,10, 8	200, 150 125 100 75 50 25 10	200, 150 125 100 75 50 25 10	200, 150 125 100 75 50 25 10		200 150 125 100 75 50 25 10	150, 100, 50, 25, 10	200, 150, 125, 100, 75, 50, 25, 10				25	150, 116, 93,83,53, 39,21,8		
25.02.	76		29°10,09 15°29,86		3607	04:44													400, 200, 100, 50, 10			
25.02.	76		29°09,97 15°30,31		3610	08:00																Shuttle start
25.02.	76		29°11,80 15°32,51		3610	14:11																Shuttle stop
25.02.	77		29°07,65 15°36,60		3614	17:30																Trap I-7 recover
25.02.	77		29°09,57 15°29,82		3608	18:26																NOAA drifter deployed

Date	Sta	Prof.	Lat N Lon W	Weather	depth /m	time start ctd (UTC)	sampling depth /m	O ₂	Alk/ pH	Chl std ICCM	Chl GeoB	Sal.	Nut	Mic	Gelb stuff	POC	N15	MN	Dil-Exp. O ₂ -Incub	N15 Incub (+HPLC, Chl, Nut)	Moorings Shuttle Free- floating traps
25.02.			29°10,0 15°30,0		3610	18:30															XBT#1
25.02.			28°29,84 15°28,66		3605	19:26															XBT#2
25.02.			28°50,13 15°27,73		3597	20:25															XBT#3
25.02.			28°40,0 15°26,0			21:30															XBT#4
25.02.			28°30,0 15°25,0			22:30															XBT#5

6.2 GeoB station list

GeoB #	Poseidon #	Date 1999	Equipment	Time	Latitude	Longitude	Water depth (m)	Comments
5601-1	51	16.02	Trap I-1	06:32	29°07,76	15°30,22	3609	Trap I-1 deployed
5602-1	52	16.02	KWS/CTD	07:02	29°08,0	15°27,1	3605	200, 175, 150, 100, 75, 50, 25, 10 Chl 150, 75, 10 Chl fractionation
5603-1	53	16.02	KWS/CTD	13:00	29°09,99	15°29,93	3610	3662, 3000, 2500, 2000, 1100, 1000 POC 3000, 1200 $\delta^{15}\text{NNO}_3$ -
5604-1	54	16.02	KWS/CTD	17:27	28°08,84	15°29,12	3610	800, 600, 400, 200, 100, 50, 10 POC 600, 400, 200 $\delta^{15}\text{NNO}_3$ -
5605-1	55	16.02	KWS/CTD	19:32	29°08,49	15°29,61	3608	75, 25 Dilution-experiment 100, 75, 25 10 Chl
5606-1	56	16.02	MN	20:42	29°08,45	15°29,78	3608	2000-1200, 1200-800, 800-500, 500-200, 200-0m
5607-1	57	17.02	KWS/CTD	05:35	29°07,03	15°55,26	3625	150, 116, 93, 83, 53, 39, 21, 8m ^{15}N -uptake
5608-1	59	17.02	Trap I-1	14:25	28°55,33	15°42,86	3613	Trap I-1 recovered
5608-2	59	17.02	KWS/CTD/ TRANS	14:47	28°55,11	15°42,81	3612	200, 150, 125, 100, 75, 50, 25, 10 Chl
5609-1	60	18.02	KWS/CTD/ TRANS	14:41	30°09,35	12°16,73	1922	250, 200, 150, 125, 100, 75, 50, 25 Chl water for traps
5610-1	61	19.02	KWS/CTD/ TRANS	04:38	30°29,94	10°36,19	2236	200, 150, 125, 100, 75, 50, 25 Chl 2000, 1500, 1200, 1000, 800, 400, 200, 100, 50, 10 POC
5610-2	61	19.02	Trap I-2	07:14	30°29,7	10°36,8	2257	Trap I-2 deployed
5611-1	62	19.02	Trap I-3	09:05	30°29,6	10°22,3	1901	Trap I-3 deployed
5611-2	62	19.02	KWS/CTD/ TRANS	09:26	30°29,39	10°21,86	1957	200, 150, 125, 100, 75, 50, 25 Chl 1900, 1500, 1200, 1000, 800, 400, 200, 100, 50, 10 POC 150, 100, 50, 25, 10m Mic
5612-1	63	19.02	Trap I-4	12:55	30°29,99	10°08,74	636	Trap I-4 deployed

5612-2	63	19.02	KWS/CTD/ TRANS	13:05	30°30,14	10°07,88	527	200, 150, 125, 100, 75, 50, 25 Chl 484, 400, 200, 100, 50, 10 POC 150, 100, 50, 25, 10m Mic
5613-1	64	19.02	Trap I-4	20:24	30°30,78	10°06,67	479	Trap I-4 recovered
5613-2	64	19.02	KWS/CTD/ TRANS	20:39	30°30,63	10°06,52	447	200, 150, 125, 100, 75, 50, 25, 10m Chl a
5614-1	65	20.02	MN	06:22	30°30,52	10°07,09	462	400-200, 200-100, 100-50, 50-10, 10-0m
5615-1	68	22.06	KWS/CTD/ TRANS	06:42	30°13,71	10°45,88	1863	150, 116, 93, 83, 53, 39, 21, 8m ¹⁵ N-uptake, water for traps
5615-2	68	22.02	MN	07:59	30°13,74	10°45,75	1857	400-200, 200-100, 100-50, 50-10, 10-0m
5615-3	68	22.02	KWS/CTD/ TRANS	09:11	30°13,69	10°45,47	1805	1772, 1500, 1150, 1000, 800, 400, 200, 100, 50, 10m TOC 200, 150, 125, 100, 75, 50, 25, 10m Chl a 150, 100, 50, 25, 10m Mic
5615-4	68	22.02	Trap I-3	12:10	30°09,4	10°47,2	1722	Trap I-3 recovered
5615-5	68	22.02	Trap I-5	12:30	30°09,1	10°47,0	1720	Trap I-5 deployed
5616-1	69	22.02	Trap I-2	14:24	29°54,0	10°58,4	1724	Trap I-2 recovered, only top buoy, rest lost
5617-1	70	22.02	Trap I-6	20:20	30°14,90	10°06,91	464	Trap I-6 deployed
5617-2	70	22.02	KWS/CTD/ TRANS	20:34	30°15,53	10°07,16	489	464, 200, 150, 100, 75, 50, 25, 10m POC 200, 150, 125, 100, 75, 50, 25, 10m Chl 150, 100, 50, 25, 10m Mic, 200, 125, 100, 75, 50, 25, 10m HPLC
5617-3	70	22.02	KWS/CTD/ TRANS	21:56	30°15,77	10°06,49	477	50, 10m Incubation
5617-4	70	22.02	MN	22:42	30°15,97	10°06,045	458	350-200, 200-100, 100-50, 50-10, 10-0m
5618-1	71	23.02	Trap I-6	06:00	30°14,31	10°05,98	435	Trap I-6 recovered
5618-2	71	23.02	KWS/CTD/ TRANS	06:15	30°14,31	10°05,98	435	¹⁵ N-Incubation 200, 150, 125, 100, 75, 50, 25, 10m Chl a
5619-1	72	23.02	Trap I-5	11:33	29°55,25	10°39,87	1441	Trap I-5 recovered
5619-2	72	23.02	KWS/CTD/ TRANS	11:44	29°55,08	10°39,74	1434	200, 150, 125, 100, 75, 50, 25, 10m Chl a

5620-1	73	23.02	KWS/CTD/ TRANS	17:52	30°03,61	11°19,77	2032	2039, 1800, 1300, 1100, 800, 400, 200, 100, 50, 10 POC 150, 100, 50, 25, 10 Mic 200, 150, 125, 100, 75, 50, 25, 10m Chl a
5621-1	74	24.02	KWS/CTD/ TRANS	03:30	29°45,65	12°43,73	1612	1623, 1300, 1100, 800, 600, 400, 200, 100, 50, 10m POC 200, 150, 125, 100, 75, 50, 25, 10m Chl a
5622-1	75	24.02	KWS/CTD	12:37	29°27,61	14°08,47	3370	3000, 2000, 1500, 1150, 800, 400, 200, 100, 50, 10m POC 200, 150, 125, 100, 75, 50, 25, 10m Chl a
5623-1	76	24.02	Trap I-7	23:13	29°09,92	15°29,26	3609	Trap I-7 deployed
5623-2	76	25.02	KWS/CTD	03:46	29°10,09	15°30,00	3608	200, 150, 125, 100, 75, 50, 25, 10m Chl a 25m Dilution experiment
5623-3	76	25.02	MN	04:44	29°10,09	15°29,86	3607	400-200, 200-100, 100-50, 50-10, 10-0m
5624-1	77	25.02	Trap I-7	17:30	29°09,57	15°29,82	3608	Trap I-7 recovered

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